

### ***Remarks***

The allowance of claims 26-27, 29-34, and 45 and the indication of allowability of the subject matter of claims 15-16, 18-25, 28, 37-44, 46, 50-52, and 54-55 is noted with appreciation.

In the amendment, claims 8, 18, 27, 28 and 52 are amended to correct formality problems and not in response to prior art rejections. The formatting of claim 17 is corrected, and claim 16 has been rewritten in independent form. Non-elected claims 62-65 are cancelled without prejudice to or disclaimer of the subject matter therein. New claims 66-68 are added to more completely claim the disclosed invention. These changes are believed to introduce no new matter, and their entry is respectfully requested.

Upon entry of the foregoing amendment, claims 1-4, 8-61, and 66-68 are pending in the application, with claims 1, 9, 16, 26, 35, 45, 46, 48, 50, 52, 53, 54, 56, 58, 60, and 61 being the independent claims.

Based on the above amendment and the following remarks, Applicants respectfully request that the Examiner reconsider all outstanding objections and rejections and that they be withdrawn.

### ***Interview Summary***

The courtesy extended by Examiners Malzahn and Do in the interview of August 5, 2004 is noted with particular appreciation. In the interview, the applicants' representative discussed claim 1 and the rejections applied to that claim based on the combination of Mayer (U.S. Patent 4,340,939) and Fox et al. (U.S. Patent 5,276,633). In particular, there does not appear to be any disclosure in the applied references of the concept of using  $\sin \theta_M$  value and  $\cos \theta_M$  values to control an angle rotation, nor is there motivation for the proposed combination of the dissimilar systems of Mayer and Fox. Although only claim 1 was discussed, these arguments apply generally to the other rejected claims. The Examiners agreed that reconsideration of the pending rejections was appropriate and that the rejections would be reconsidered upon filing of a formal response.

***Response to Rejections under 35 U.S.C. § 112***

Claim 8 has been amended to overcome the problem noted by the Examiner. This change clarifies and broadens claim 8 and is not made for purposes of distinguishing claim 8 from the prior art.

Claim 17 is presented in the above amendment in correct format as originally submitted. A printer error in the last amendment resulted in printing the equation in the wrong location in the text, creating the indefiniteness noted by the Examiner. It is respectfully submitted that the original claim, as correctly reproduced above, does not have the noted problem.

In response to the objections to claims 46, 50, 52, 54, 56, 58, and 60, and their dependent claims 47, 51, 55, 57, and 59, reconsideration of the objections is requested based on the following remarks.

Applicants respectfully submit that the term "representing" in these claims is clear and definite. This language is intended to encompass both an actual value of the indicated trigonometric function and an approximation of such a value, as well as other representations of the values such as normalized representations.

It should be noted that trigonometric functions often have values with a large number of digits to the right of the decimal point. In particular, most values of trigonometric functions are irrational, i.e. cannot be expressed as a fraction and therefore actually have an infinite number of digits to the right of the decimal point. A trigonometric function value with a large or infinite number of digits must be truncated or otherwise approximated if it is to be used in electronic calculations, and for the reasons disclosed in the specification it may be desirable to use an approximation even when there is a capacity to process additional digits. Therefore, those skilled in the art will understand that some approximation is inherently involved in representing most trigonometric values. In particular, even where the claims merely recite that a trigonometric value is used, it will be understood by those skilled in the art that this may not be a precise value. The term "representing" as used in the indicated claims broadly covers exact values, approximations thereof, and normalized representations, any of which could be used in the claimed methods. It is submitted that the term "representing"

is appropriate in view of the foregoing discussion, and can be readily understood by those skilled in the art. Reconsideration of the pending objection is requested.

***Response to Rejections under 35 U.S.C. § 103***

Claims 1, 3-4, 8-14, 35-36, 48, and 56 were rejected as obvious based on the combination of Mayer (U.S. Patent 4,340,939) and Fox *et al.* (U.S. Patent 5,276,633). This rejection is respectfully traversed, and reconsideration is requested based on the following remarks.

The Office Action suggests that it would be obvious to add a memory device of the type shown in Fox *et al.* to the coarse approximation circuit of Mayer. Applicants respectfully submit that these two circuits are basically incompatible and that the suggested modification of the Mayer reference would not produce the claimed invention. Among other factors, even if the circuits were combined as suggested in the Office Action, they would still not have all the features recited in the claims, including for example the feature of using  $\sin \theta_M$  value and  $\cos \theta_M$  values to control an angle rotation. Finally, as will be seen, a person skilled in the art would not be motivated to combine these circuits in the manner suggested.

***A. The Proposed Combination does not Provide the Claimed Features***

The proposed combination of Mayer and Fox fails to provide all the features of rejected independent claims 1, 9, 35, 48 and 56.

**Using  $\sin \theta_M$  value and  $\cos \theta_M$  values as angle rotation inputs.** Independent claims 1, 9, 48 and 56 recite that  $\sin \theta_M$  value and  $\cos \theta_M$  values are stored in a memory and used as inputs to a digital angle rotation circuit. Neither reference used in the rejection discloses or suggests this feature. Mayer does not have a memory and does not use these values as inputs to his digital angle rotation circuit. The Fox patent discloses only a sine/cosine *generation* system, which is not an angle rotator. The assertion at page 5, lines 1 and 2 of the Office Action, that “Fox *et al.* disclose in Figure 3 extensively a sine/cosine generation for using in rotating angle by coarse and fine adjustment” is respectfully traversed. There is no disclosure at all in Fox relating to angle rotations. The output of the Fox circuit is a single high-precision sine value (363)

and a single high-precision cosine value (364). Moreover, the Fox circuit does not even produce both coarse and fine sets of sine/cosine values that could be incorporated into a digital circuit such as the circuits employed in the present invention.

**Trigonometric approximations.** Claim 35 recites the step of determining a first value that is an approximation of  $\sin \theta_M$ , and determining a second value that is an approximation of  $\cos \theta_M$ . The Office Action suggests that Mayer's element 48 performs this function. However, Mayer's element 48 is merely a decoder. It does not determine a value that represents an approximation of  $\sin \theta_M$  or  $\cos \theta_M$ . The input of element 48 relates to a trivial angle of either 0, 90, 180, or 270 degrees, and its output is to activate one of output wires 54, 56, 58, and 60 to open or close the switch/relay through which the analog input signal is routed. Thus, no determination of first and second values that represent  $\sin \theta_M$  or  $\cos \theta_M$ , either exactly or approximately, is provided by decoder 48. Nor does any other element of Fig. 5 provide this function. Again, the Fox device has a different design that is not compatible with the analog system of Mayer, and has no disclosure of using the recited trigonometric functions as inputs to an angle rotator.

**Digital processing.** Each of the rejected claims recite digital processing. The analysis in the Office Action suggesting that "Mayer discloses ...digital circuit (20)" is incorrect. The coarse input stage (20) of Mayer is an *analog* circuit that routes *analog* inputs to *analog* outputs. See, for example, column 3, lines 21-26 of Mayer, where it is stated that "As shown in FIG. 2, analog voltages E(X1) and E(Y1) corresponding to the orthogonal coordinates X1, Y1 are applied to input terminals 17 and 19 of a coarse-angle resolver 20." Mayer also explicitly describes a resolver as being an "electro-mechanical device" (on line 20, column 1). The routing of Mayer's analog input signals to the analog outputs is controlled by electromechanical relays. Mayer calls them "switches" in, for example, his description in column 7, at lines 46-48: "If the signals on terminals 1 and 2 of decoder 48 are both zero (00), then the decoder output terminal 54 is energized closing switches 32 and 34." Later in column 7 (at lines 62-66) he explicitly refers to the outputs produced by 20 as being [analog] voltages.

While Fox shows digital circuits that are not angle rotator circuits, there is inadequate motivation for the proposed combination of these two circuits as will be explained below.

**Memory device.** Independent claims 1, 9, 48 and 56 recite a memory device. As the Office Action admits, the Mayer device does not include a memory that stores a representation of  $\sin \theta_M$  or  $\cos \theta_M$ . A memory device would have no obvious purpose in Mayer's electromechanical/analog relay-type system. Claim 9 recites in more detail that the memory stores "one or more values that are indexed by a most significant word (MSW) of said input angle." The MSW part of Mayer's input angle comprises only the two-bit word  $E(A_1)$ . This word is fed directly to the adder of Mayer's Fig. 2 and is not used to index a memory. Thus, Mayer even more clearly does not disclose the structure recited in claim 9.

Fox discloses a memory, but in a different context and for a different purpose. As will be seen, there is inadequate motivation in the references relied upon in the Office Action for a modification of Mayer that would produce the claimed invention.

***B. Lack of Motivation***

To make out a *prima facie* case of obviousness, the combination must provide each and every feature of the claimed invention and there must be some clear motivation to make the combination set forth in the references relied upon for the rejection.

There is no teaching in either of the references used in the rejection that would motivate a person of ordinary skill in the art to use  $\sin \theta_M$  and  $\cos \theta_M$  values as inputs to an angle rotation circuit as recited in each of the rejected claims. Mayer does not teach this feature of the rejected claims. Fox does not even relate to an angle rotator and does not remedy the deficiencies of Mayer in this regard.

Further, with regard to the proposed grafting of a memory into the Mayer circuit, there is no obvious way to combine Mayer's analog system with one where *digital* signals (for example, sequences of binary 0/1 bits representing values of sines and cosines of specific angles) are generated. Mayer fails to disclose or suggest the specific digital circuits recited in all of the pending claims. The proposed combination would require a complete redesign of the Mayer circuit to make it a digital circuit, incorporating features of the dissimilar Fox circuit and additional features not suggested by the references relied upon in the Office Action. It is not even evident that the Fox invention could be combined with the Mayer resolver (20) in a way that would produce any useful result. In view of the analog nature of the Mayer coarse-angle resolver (20)—or, for that

matter, the Mayer fine-angle resolver (22), which also processes *analog* signals, a memory device of the type disclosed in Fox could not functionally interact with the Mayer circuit. There is no indication of where such a device could be added in the Mayer circuit so that it would function in accordance with Mayer's analog resolver circuits. The two devices are essentially incompatible in terms of signals and operation.

Mayer teaches that the best way to build an angle rotator is to use analog signal processing. This teaching of Mayer is fundamentally incompatible with the proposed redesign of Mayer to include elements of the Fox sin/cos generator circuit. Persons skilled in the art would therefore not be motivated to combine a reference that teaches an analog signal processing approach for angle rotators, with features of a circuit that has a different purpose and teaches in the opposite direction. Motivation for such a combination can only be found through reliance on impermissible hindsight.

### ***C. Unobvious Advantages***

Even if the references did make out a *prima facie* case of obviousness, any suggestion of obviousness is overcome by the unobvious results achieved by the invention. The memory recited in independent claims 1, 9, 48 and 56 and the functions performed by that memory provide significant unobvious advantages in the context of the invention. The combination of both memory and computation yields the major advantages exhibited by embodiments of the invention as described in the specification. Without using memory, for example, it would still be possible to create an angle-rotation device. In such a case, however, (unless all rotation angles are trivial) the amount of computational circuitry would increase very significantly—yielding a device that is far less desirable. Further, the feature of using the memory that stores a representation of  $\sin \theta_M$  or  $\cos \theta_M$  makes possible particular speed and cost advantages in embodiments of the present invention. The present invention therefore provides an angle rotator that is faster and less expensive than prior art systems.

### ***D. Remarks on Dependent Claims***

The rejections applied to the dependent claims are similarly traversed. Each of the dependent claims 3, 4, 8, 10-14, and 36 is believed to be independently patentable, as well as being patentable for the reasons given above with regard to the features of the

independent claims. Therefore, this response will not address each distinctive feature of the dependent claims. The following remarks describe a few of the independently patentable features recited in the dependent claims.

Claims 3, 4, and 10-14 recite various digital circuit features, including a digital butterfly circuit, features performed by a second *digital* circuit, and/or other digital circuit features as shown above.

Claim 3 recites the presence of a “butterfly circuit” in the first digital circuit. Mayer’s “first circuit” is not “digital” as discussed above. Beyond that, however, Mayer’s first circuit does not possess a butterfly circuit. If it did, its topology would consist of four separate paths, with each path connected directly between one of the input terminals and one of the output terminals (there are exactly four ways to do this, corresponding to the four branches of the butterfly circuit—see any of our many figures where such a butterfly structure is displayed in both our first stage and our second stage). In addition to the butterfly topology, each of the two output nodes is comprised of a two-input adder, for which the branches of the butterfly circuit connect to the adder inputs. Finally, each of the butterfly circuit’s “plurality of multipliers” is dedicated to a single branch. The Mayer first circuit does not possess the required butterfly topology, nor does it display an adder at each output node. The Mayer circuit also contains no multipliers. Since one of the four input-angles accommodated by the Mayer first circuit’s control signal  $E(A_1')$  can be chosen for which any specified one of the four butterfly branches would require an inversion operation, it follows that the Mayer first circuit cannot be a butterfly circuit.

Claim 4 recites the presence of a “butterfly circuit” in the second digital circuit and the arguments relating to claim 3 also apply to claim 4. In the case of Mayer’s second circuit, the presence of feedback in his second circuit’s topology proves that it does not possess a butterfly circuit structure even in analog-circuit form. This presence of feedback is totally out of accord with a butterfly circuit, which has a strictly feed-forward topology. Claims 10 and 11 also recite a butterfly circuit that is not disclosed or suggested by these references.

Those skilled in the art would not be motivated to create any digital circuit based on the Mayer disclosure, nor would they be motivated to attempt an obviously inoperable combination of digital elements of the Fox circuit with the Mayer circuit. As noted in a

prior response, Mayer's feedback structure, essential for Mayer's circuit operation, is achieved via resistive analog components. This type of circuit *could not* be imitated in digital form. Trying to do so would require a digital circuit with delay-free loops, and such a circuit cannot physically function. Fox does not remedy the deficiencies of Mayer in teaching the features of these claims.

Claim 8 recites that a ROM is indexed by  $\theta_M$ . The assertion in the Office Action that teachings from Fox could be combined with Mayer to provide this feature is respectfully traversed. Contrary to the assertion in the Office Action, Mayer does not have a PROM that performs the claimed features.

With regard to claim 36, as noted previously, element 48 of Mayer's device is not a memory, so there is no way that Mayer can disclose or suggest retrieving the first value and second value from a memory as recited in claim 36.

Reconsideration of the rejections based on Mayer and Fox is appropriate in view of the foregoing remarks.

#### ***Response to Objection to Prior Amendment***

The assertion that the previously submitted amendment introduces new matter is respectfully traversed, and reconsideration is requested.

Claim 2 is supported by the disclosure at pp. 77-79, among other references. On page 118, line 17-18, one's complement negation is disclosed with reference to box 7120, shown in Fig. 71. The ones' complement of the input to box 7120—that is, the ones' complement of  $X_1Z_1$ —is the same as the two's complement of  $X_1Z_1$ , i.e.,  $(2 - X_1Z_1)$ , except for a small error due to the ignoring of an LSB carry-in bit. Those skilled in the art would understand this relationship, and the possibility of using ones' complement negation instead of twos' complement negation is specifically addressed on page 126, lines 15 and 16. This relationship is further described at page 95, lines 19-22, where, the relation between ones' complement negation (i.e., the XOR operation) and two's complement negation is explicitly discussed. The same principle applies to the operation recited in claim 2, with  $\theta_L^2/2$  playing the role of  $X_1Z_1$ . In the case of claim 2, the desired quantity is  $(1 - \theta_L^2/2)$ , which differs from the computation of  $(2 - \theta_L^2/2)$  only trivially, as would be recognized by one skilled in the art. The natural way to perform



the computation  $(1 - \theta_L^2/2)$  for a fractional-valued  $\theta_L^2/2$  would be to perform a two's complement negation of  $\theta_L^2/2$  and ignore the negative sign bit. In this regard, on page 93 at lines 27 through 30, the inventors disclose a conditional subtract operation wherein a fractional quantity is to be subtracted from 1, a consequence of the use of *normalized* angle representations. Discussion of this feature begins on page 92, with normalized representation mentioned explicitly starting on line 24 and continuing through the next page. This equivalence of a fractional value's subtraction from 1, on the one hand, and a two's complement negation of the quantity to be subtracted, on the other, is described in lines 27-30 of page 93.

Operations involving selective application of a two's complement, such as in claims 53 and 61, are disclosed in detail in the specification at pages 92-100, among other relevant disclosures. For example, the stripping of most significant bits and even/odd octant determination is discussed on page 93, line 24 through page 94, line 3. It is also discussed on page 99, line 25 through the top lines of page 100, where the conditional negation of remaining LSBs is described. Figs. 56, 57, 47, and 48 provide further support for this feature.

Claims 56, 58, and 60 employ fine adjustment values such as those mentioned in claim 57 (and claims 49, 51, and 59). These claims are supported by, for example, the discussion in the specification on pages 65 through 75 and by the discussions pertaining to Figs. 55, 56, and 57 including the discussion on pages 99 and 100.

Claims 49, 51, 57 and 59 are supported, for example, by pages 69-75 of the specification. See, in particular, equation (5.43) on page 72 and Figures 39, 40, 42, 44. The features of these claims are further supported by the discussion in the specification relating to equation (5.30).

In view of the above explanation and references, it is respectfully submitted that the pending claims are supported by the specification as filed and do not include new matter.

### ***Conclusion***

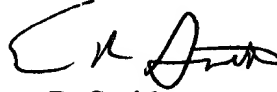
All of the stated grounds of objection and rejection have been properly traversed, accommodated, or rendered moot. Applicants therefore respectfully request that the

Examiner reconsider all presently outstanding objections and rejections and that they be withdrawn. Applicants believe that a full and complete reply has been made to the outstanding Office Action and, as such, the present application is in condition for allowance. If the Examiner believes, for any reason, that personal communication will expedite prosecution of this application, the Examiner is invited to telephone the undersigned at the number provided.

Prompt and favorable consideration of this Amendment and Reply is respectfully requested.

Respectfully submitted,

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